



Social Impact of Renewable Energy Sources in the Province of Loja: Ecuador



Julio Cesar Hernández Chilán ^a, Stalin Geovanny Paucha Torres ^b, Byron Ignacio Fernández Machuca ^c, Anthony Joel Tandazo Cordova ^d, Carlos Alfredo Mendoza Pérez ^e, Maria Rodriguez Gámez ^f

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Correspondence Author ^a



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Abstract

In the future energy development of the planet, renewable energies are decisive, because of the benefits that these entail in their use, besides being inexhaustible; These are used in different ways, in heating in electrical energy, electrochemistry, among others. These energy sources in its implementation have had a social impact by generating jobs, improving the quality of life in remote areas, improving health by reducing pollution; In addition to the levels of knowledge reached not only by professionals but also the population in general. In Ecuador, during the last 10 years, in the introduction of renewable energies, fundamentally hydraulic projects have been worked on. Which four are already in operation, this is how the country has been consolidated, being one of the most energy-rich in the region, in the same way, this has generated sources of work for many people; besides avoiding large pollution to the atmosphere. In the province of Loja, a wind farm, photovoltaic power plants are deployed, and public lighting with photovoltaic systems is used in some sectors of the City. The objective of the work is to demonstrate the social impact that the introduction of these technologies has had in the province of Loja, not only in the social sphere but also cultural, economic, environmental and tourist.

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^a Master, Assistant Professor, Career Engineering in Electricity, Universidad Técnica de Manabí, Portoviejo, Manabí

^b Student of the Engineering Degree in Electricity, Universidad Técnica de Manabí, Portoviejo, Ecuador

^c Student of the Engineering Degree in Electricity, Universidad Técnica de Manabí, Portoviejo, Ecuador

^d Student of the Engineering Degree in Electricity, Universidad Técnica de Manabí, Portoviejo, Ecuador

^e Student of the Engineering Degree in Electricity, Universidad Técnica de Manabí, Portoviejo, Ecuador

^f Ph.D. Professor and researcher, Career Engineering in Electricity, Universidad Técnica de Manabí, Portoviejo, Ecuador

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1. Introduction

The accelerated consumption of fossil fuels for the generation of energy will eventually lead to its scarcity. These energetics were formed from solar energy for millions of years and are being consumed at an unsustainable rate. Fortunately, there is a source of energy that is inexhaustible, the sun, the origin of other renewable energy sources (RES) such as wind, bioenergy, hydraulics and solar energy, among others. According to the International Renewable Energy Agency (IRENA). In its study in conjunction with the SENER called REmap2030 1, Mexico has the potential to generate up to 46% of electricity from RES each year, which represents 280 TW-h, 26% of which can be generated through wind and solar photovoltaic energy [1].

The impulse of RES is a strategic axis worldwide that seeks mainly to prevent the eventual depletion of fuels, besides avoiding the toxic effects of the production and use of these. This represents two goals: energy security and environmental sustainability; Likewise, these impact transversally to economic development, social welfare, and globally contribute to sustainable development. In Latin America, its impact has been considerable, since they have put together great powers such as China and the United States and even leading the lists of the countries with the highest renewable energy index, these are Chile, Mexico, Uruguay and Brazil among others.

In the social aspect, multiple benefits can be mentioned the creation of regional jobs; a better standard of living in remote areas with access to electricity, stoves and solar heaters or from biogas; better health due to less pollution; and technical or professional improvement. Due to the degree of specialization necessary to install or produce technologies that take advantage of the RES. A study carried out in the Chone canton of the province of Manabí, has raised the social impact of the use of the RES in the local development, oriented to achieve sustainability and energy independence with the use of the native resources. In this environment the technologies that They take advantage of the wind energy they are one of the most propitious in places of low wind speed [2].

In the environmental aspect, the use of RES contributes to the mitigation of effects caused by the emissions of gases that produce climate change, as well as a decrease in the concentration of toxic particles in air, soil, and water [3]. The ability of humanity to extract and use fossil fuels has been the catalyst for technological and industrial development that has led to unprecedented socio-economic prosperity in many regions of the world. While advocates of non-renewable energy systems argue that fossil fuels will continue to be much more feasible than RES, environmental advocates and organizations such as the United Nations argue that sustainable energy can also have a positive economic impact.

The cost of renewable energy sources is not as prone to market fluctuations, such as oil or natural gas. Solar and wind energy systems are capable of supplying energy to developing or less accessible regions, which in most cases do not have the economic resources or infrastructure to use fossil fuels. In addition, experts predict that the increase of investment in systems that benefit the RES, allows thousands of jobs to be generated. Most environmental advocates argue that the technologies that ERPs use do not create carbon dioxide emissions in their exploitation stage, so they do not contribute to climate change, unlike the nuclear and oil industry that produce byproducts and hazardous waste that can severely damage or destroy ecosystems. Despite these positive aspects, when implementing them we must take into account their impacts on the environment, which can be rewarded by appropriately managing the environment.

For example hydroelectric projects such as dams can negatively affect biodiversity and wildlife by obstructing natural water currents and water reserves that can change the ecosystem unalterable. Another concern concerning environmental impacts is the amount of agricultural land that may be needed to generate significant levels of biomass energy, as well as the amount of air pollution that is derived from the use of biomass compared to other renewable systems.

Due to the various economic and environmental impacts of systems based on renewable energy sources, increasing the use of sustainable energy will likely have important social consequences. For example, the widespread use of systems based on the use of renewable energy sources can lead to an increase or decrease in employment rates in some regions, depending on their industrial base. If they are dependent on fossil fuels; other social impacts could include greater freedom of choice of consumers about a domestic energy supplier; changing political relationships at the international level as certain nations end their dependence on third parties for energy. The expected improvements in health, as more and more citizens, will not be exposed to hazardous waste and emissions associated with fossil fuels [4].

2. Research Method

The research method selected for carrying out the work has been the transversal deductive, as an essential form of reasoning, as well as an object of study of logic and research. These concepts allowed us to analyze the problem posed to later reach precise conclusions related to the world and Ecuador's energy development, where the need to abandon the path of oil and to undertake energy sustainability based on the optimal use of the available renewable sources of energy stands out territorially. The bibliographic review technique was put into practice based on knowledge of the impacts related to the use of fossil fuels to generate energy and the role of RES at the global level, as a viable alternative to reduce the environmental consequences derived from the energy activity, taking the particular study of the province of Loja, with the objective of carrying out the analysis at national and local level.

3. Results and Analysis

To refer the environmental impacts of the introduction of the RES in the province of Loja, it is necessary to assess the international situation is knowing the countries that today have the greatest introduction of the RES and therefore greater social impact. Figure 1 shows the countries that have the highest energy generation based on the use of renewable sources of energy in GW / h, including hydro generation [5].

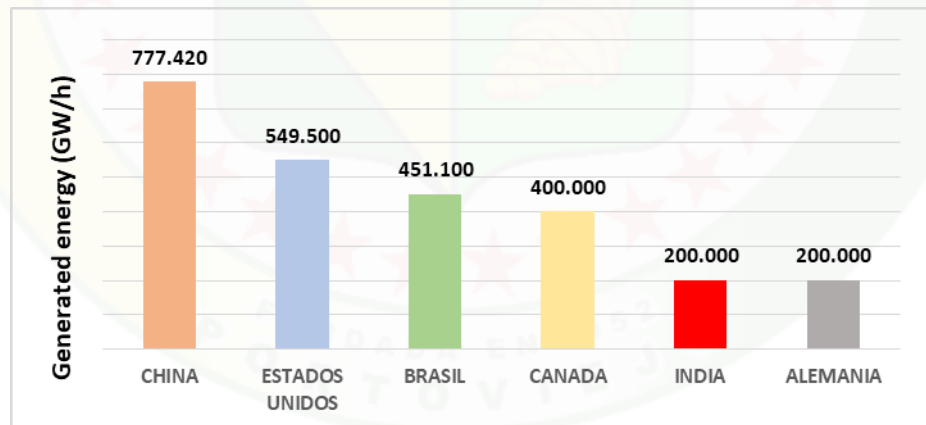


Figure 1. Countries with the highest level of generation based on the use of renewable energy sources

3.1 Renewable energy sources in Latin America

In Latin America three sources are the pillars of the RES; These are hydropower, the wind industry, and solar energy. The wind industry is the youngest and smallest of the three that are examined in the study and which has had the least impact on the environment and society. The two countries that currently have the greatest generation capacity from this source in Latin America are Brazil (256 MW) and Mexico (88 MW).

The largest wind farm in Latin America is located in Brazil in the municipality of Osório and includes three Sangradouro, Osório, and Dos Índios projects, which have a generation potential of 150 MW. For its part, in Mexico, the most important is the La Venta II wind farm, located on the Isthmus of Tehuantepec, in Oaxaca, whose potential is close to 84 MW. The hydroelectric power plant is the main source of electricity generation in Latin America and 2006; it contributed nearly 60% of the total electricity generated. The low operating costs and the high efficiency of the hydroelectric plants, as well as the great potential of the region, have been one of the factors that have led to its wide expansion throughout the region. Currently, only Barbados, Granada and Trinidad and Tobago do not have hydroelectric power plants. Brazil is the main producer country, since it contributes more than 35% of the total generation of the region, and 83% of the energy consumed corresponds to hydroelectric power plants [6].

The growth of investment in the solar market in Latin America, the growing concern for the environment and new job opportunities, are some of the reasons why more people choose a career in solar energy. Currently, two million people work in the renewable sector in Latin America, with a 40% increase in solar power installed worldwide, a 60% reduction in the price of solar installations, being rated 2015 as a good year investments, where 56% of the electricity produced in Latin America came from renewable sources, and it is proposed that by 2025, 50% of the electricity capacity could be generated with solar energy [7].

During 2015, the countries that led the ranking of investments in clean energy generation projects were China, India, and Brazil, which contributed US \$ 156,000 million of the US \$ 285,900 million that the global investment reached (that is, 55%) of that total). The upward trend is due, among other factors, to the fact that developing countries have the highest energy demand, while the installation costs of solar panels and windmills were reduced, which allowed the Renewable energies will continue to be a profitable investment. Thus, although capital does not usually come from the States but private companies, the implementation of public policies in different countries aimed at capturing and promoting investments for the industry, modified the traditional configuration of the production map of this type of energies [8]. Figure 2 graphically shows the investment ratio in billions of dollars in renewable energy sources by Latin American countries between 2009 and 2014.

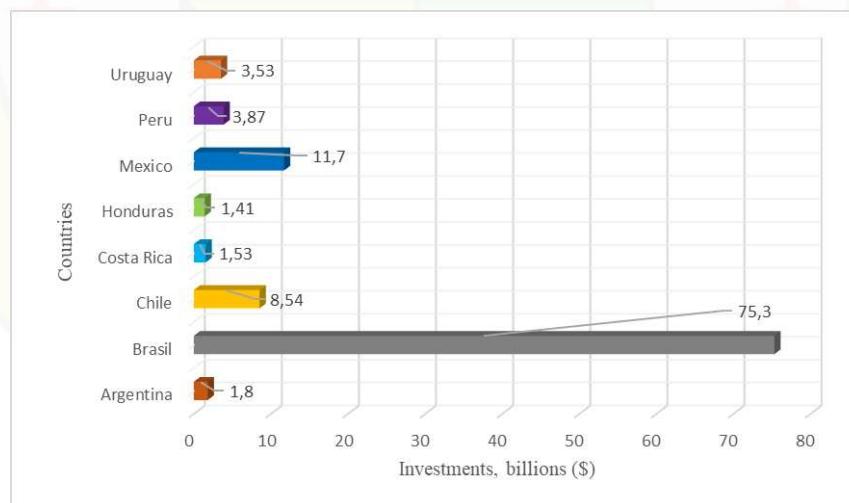


Figure 2. Relationship of investment in billions of dollars by Latin American countries

Consequently, the development of the ERW is an important contribution to cover the growing demand of energy in the populations of Latin America and the Caribbean, which presents a period of sustained economic growth that will help improve investments. It is in this sense that the Latin American states implement public policies of promotion and subsidies for energy projects from clean sources, which is translated into an increasing preponderance of the region in the development of these clean energies.

As shown in table 1, the countries of the region that invested more than one billion dollars during the last year are Brazil, Mexico, Uruguay and Chile (the latter, considered the undisputed leader in the

development of solar energy in the subcontinent. While in fourth and fifth place are Honduras, with the US \$ 567 million, and Peru, with the US \$ 155 million.

Table 1
Investments in RES by Latin American countries

Country	Investments 2015 (\$)	Installed potency (GW)	Proportion of Renewables on Installed potency (%)	Total Clean Energy Generation (GWh)	PBI (\$)
Argentina	1,6 MM*	31.41	2	2,626.11	540.20
Brasil	7,1 MM	138.43	18	87,282.14	2,346.12
Chile	3,4 MM	19.22	13	8,307.72	258.06
Costa Rica	100 M	2.85	35	4,614.76	49.55
Honduras	567 M	1.85	25	1,316.23	19.39
México	3,9 MM	64.03	6	15,945.20	1,282.72
Perú	155 M	10.83	10	4,264.77	202.90
Uruguay	1,1 MM	3.72	24	2,025.32	57.47

3.2 Social impact of non-renewable energies in Ecuador

When talking about sustainability, attention is usually directed to environmental, economic, and social or development aspects that are required to ensure the present and future generations' well-being. But, in a few occasions it is considered that energy is the factor on which the functioning of the whole natural or artificial system depends and that its provision and/or management is an urgent and non-transferable priority, immediate as well as perennial, individual and collective, of environmental conservation, both for the socio-economic, political and operational development of the country.

The Ecuadorian energy sector is at a point of transition, as stated by the Minister of Electricity and Renewable Energy [9]. Since despite all the advances in the constitutional precepts on management and sustainability in energy matters, the energy supply, and demand system is currently not sustainable, and the consolidation of renewable energy sources in the national energy matrix is still incipient.

It can be affirmed that between the years 2008-2009, the Ecuadorian energy sector did not guarantee self-sufficiency to meet a demand that grows every year, nor did it ensure sustainability in economic, environmental or social terms. This contradiction for a country that is defined as oil can be explained, if we consider that the exploitation of the Amazonian crude is based on external demand and the international price system, undervaluing it as a raw material (energy commodity). Even worse, after four decades of exporting crude oil, the country still imports petroleum derivatives to improve domestic production of poor quality fuels and supply a market for state-subsidized fuels. This has meant for the country an expense equivalent to half of the external debt in derivatives and subsidies during the last decade, to more than the millions of tons of CO₂ emitted into the environment and the lack of incentives for sustainable consumption, because of the low prices [10].

The challenges of changing the energy matrix are already a reality. The important investment made by the National Government is presented to the public with concrete actions, mainly with the implementation of the emblematic works, which have contributed so far, to replace fossil fuel consumption by 51.78% in the production of renewable energy, which represents 13,638.89 GWh distributed for the benefit of Ecuadorian society. Figure 3 shows the production of energy and imports graphically in GWh.

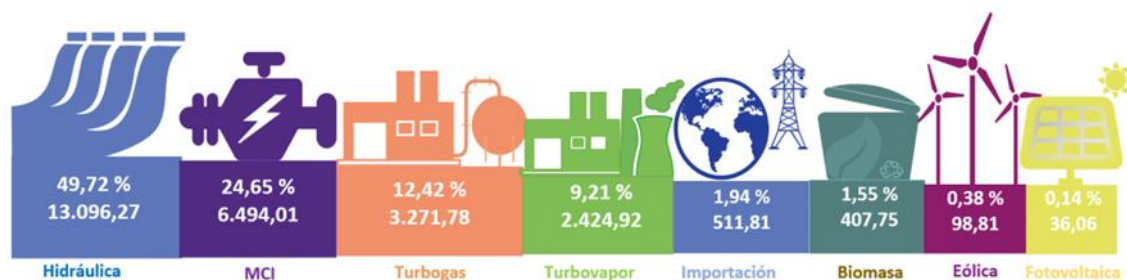


Figure 3. Energy production and imports in GWh

Source: Statistics [Arconel 2015](#)

This historic milestone is the mark of the energy revolution aimed at strengthening the country's economy. The purpose is to achieve 93% of clean and renewable energy, taking advantage of the potential of natural resources such as water, solar, wind, and gradually discarding the production of polluting energy. Ecuador is currently a world leader, ranking fifth in energy security according to a report from the University of Vancouver and standing out for its enormous efforts in the construction of its eight hydroelectric projects [11]. Hydraulic power is the largest used in the country, and currently, the most power generated.

The one that less power generates at the moment is the photovoltaic energy. It should be noted that Ecuador is in a privileged location in terms of solar radiation, to be found among the countries of the solar belt, in addition to being located on the equatorial line that divides the planet and where the solar rays arrive with greater perpendicularity. In addition, this does not change during the year, and there is a constant angle of incidence, characteristics that give photovoltaic solar energy an important potential for exploitation [12].

3.3 Social impact of wind energy in Ecuador

The country year after year is surpassed in the RES, and one of them is the wind power. The first wind farm in the country was inaugurated in October 2007 on San Cristóbal Island of the Galápagos Archipelago, with an installed capacity of 2.4 MW. In 2014, the inauguration of renewable energy projects, Eólico Baltra and the Puerto Ayora photovoltaic park, as part of the Zero Fossil Fuels initiative in Galapagos, aimed at reducing the use of petroleum derivatives in the generation of electricity, in this area of high environmental and social sensitivity of the country. In the Galápagos Islands, the RES is important because they are clean energies that do not affect the ecosystem, and currently, the renewable source that presents a greater contribution is the wind

3.4 Social impact of RES in Loja

In 2013, the start-up of the Villonaco Wind Farm began, which supplies energy to the National Interconnected System, being cataloged as a system connected to the grid. This project was the first to be built in continental Ecuador at the height of 2,720 meters above sea level; its first impact is that it does not emit polluting emissions into the atmosphere, socially benefits the inhabitants of the provinces of Loja and Zamora that enjoy a better quality electric service.

In some Cantons of the Province there are also some small sources of renewable energy that benefit the communities, not with the impact that large systems generate, but they help a lot in the local space, in such a way that jobs are created, and these contribute to the care of the environment, generating clean energy and boosting local development with the use of indigenous resources [13].

Loja is one of the provinces of Ecuador, which has increased interest in the field of RES with the desire to have a sustainable city. It was here that the first hydroelectric power station in the history of Ecuador was built on April 1, 1899. The residents of Loja observed how the city was illuminated, for the first time [14]. Currently, it recycles urban waste, maintaining a healthy and sustainable environment, incorporating photovoltaic systems connected to the grid, a sector with public photovoltaic luminaires and a wind farm. These projects support ecological tourism in the city, generating income that in one way or another

translates into benefits for Loja households and the population. This province currently has 3 different sources of electricity generation through non-renewable energies, which are:

Wind power

The Villonaco Wind Power Plant of 16.5 MW, which began construction in August 2011. It has 11 wind turbines of 1.5 MW each. It is the first wind project in continental Ecuador, besides being the first in the world with an average annual speed of 12.7 m / s at an altitude of 2700 meters above sea level. The project is located in the Loja canton, in figure 4 an image of the Villonaco wind farm is shown.



Figure 4. Villonaco wind farm

The wind farm is integrated by 11 wind turbines of type GW70 / 1500, which are located at an approximate height of 2700 meters above sea level, along with the summit line of the Villonaco hill with an approximate distance of 2 km. The elevation substation is 34.5 kV / 69 kV with a capacity of 25 MWA and presents a scheme of connection of main bus and transfer. The Loja substation contemplates the installation of a 69 kV bay, which receives the energy from the Villonaco substation to be connected to the National Transmission System.

It is an emblematic project of the Ecuadorian state that is operating in a normal and continuous manner based on the requirements of the Ecuadorian electric system since January 2, 2013, contributing to the National Interconnected System a net energy of 332.38 GWh from its entry into operation in July 2017, reducing CO₂ emissions by approximately 32 thousand tons / year, replacing the importation of energy, and creating 254 sources of direct employment, additionally benefits more than 200 thousand inhabitants corresponding to the Loja canton, serving as basis for study of different schools at different levels of education

Photovoltaic energy

Since 2014 there are several photovoltaic parks operating in Loja, these were developed with different international institutions, example of which is: Zapotillo (photovoltaic project that works in the La Ceiba Chica and Grande communities, included between the Garza Real parishes and the cantonal head, towards the north of the border city with Peru), the La Era solar park (2 MW), formed by Renova Loja SA and Surenergy SA, the Gonzanamá solar park (2 MW). Figure 5 shows an image of the photovoltaic park mentioned above.



Figure 5. Solar park installed in Gonzanamá (2 MW)

There are other facilities that generate less power, which is located in rural areas of the province, as well as lighting avenues with photovoltaic lights.

The energy of biomass

In the canton of Catamayo, the Monterrey Company has a project for the production of energy through Biomass. Loja is an entrepreneurial province in terms of the use of the RES, its social impact has benefited the populations living near these facilities, thanks to the implementation of new practices has been achieved the improvement of infrastructure and equipment of educational centers, provision of supply electricity to the parishes of Sucre and San Sebastián, improvement of roads, training to the residents of the area in phytosanitary control of crops, gardening and maintenance of green areas, works executed through the CELEC EP Business Unit GENSUR.

The generation of jobs has been one of the factors of consideration, since groups of Ecuadorian employees have been trained to install systems of any energy, empowering the company of Loja to acquire the necessary technical knowledge and then participate in other projects of the same type, not only in the country but the rest of South America. In Villonaco Park, for example, the professionalism and commitment of the Ecuadorian workforce and the seriousness of the Government and national contractors were proven. The environmental impact has been managed with the repopulation of endemic plants, reseeding plantations of the same species that exist in the area and that were removed to open the access road and to raise the towers.

The benefits obtained are linked to environmental protection and social development, also economically because of the contribution that occurs in the production of clean energy without any expenditure of fuel or polluting emissions; only with the use of local resources offered by nature. The annual generated wind energy replaces a thermally generated energy that would need 4,495,000 gallons a year, therefore, it reduces the purchase of diesel fuel that implies a saving of \$ 13 260,000 dollars per year, thus avoiding the emission of greenhouse gases greenhouse in a volume that amounts to 35 270 tons of CO₂ per year. The project will serve to supply 25% of the annual energy consumption of the Province of Loja. Likewise, it will cover 68.7% of peak demand in the Loja canton and 40% of the demand of the concession area of the Southern Regional Electric Company (Loja, Zamora, and part of Morona Santiago). While the social benefits are 90% oriented for jobs in local squares, generating 257 direct jobs and 760 indirect jobs [16].

4. Conclusion

The investigation made it possible to verify that the province of Loja is an example and pioneer in Ecuador in the use of local resources offered by nature to generate clean energy, providing knowledge and job creation to the linked populations, not only with projects but also to those who receive that clean energy in their homes. The study confirms that the introduction of renewable energy sources allows a secure path to achieve the energy sustainability of development, as it promotes the saving of natural

resources, reduces the cost of energy and helps reduce the environmental impact derived of electricity generation.

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Biography of Authors

	A graduate of Electrical Engineering at the Universidad Técnica de Manabí (UTM), Portoviejo, Ecuador. Magister in Teaching and Educational Research. Assistant Professor of the Department of Electrical Engineering at the Faculty of Mathematical, Physical and Chemical Sciences of the Technical, Portoviejo, Ecuador. He currently carries out his doctoral work on the technology theme to improve the behavior of variable speed synchronous wind turbines in front of the voltage gaps
	Stalin Geovanny, Student of the Engineering Degree in Electricity, Universidad Técnica de Manabí, Portoviejo, Ecuador
	Byron Ignacio, Student of the Engineering Degree in Electricity, Universidad Técnica de Manabí, Portoviejo, Ecuador.
	Anthony Joel, Student of the Engineering Degree in Electricity, Universidad Técnica de Manabí, Portoviejo, Ecuador
	Carlos Alfredo, Student of the Engineering Degree in Electricity, Universidad Técnica de Manabí, Portoviejo, Ecuador



Professor and Researcher of the Universidad Técnica de Manabí, Portoviejo, Ecuador. Bachelor in Education, Specialization: Physics and Astronomy, Master in Spatial Planning and Development in Renewable Sources of Energy, Ph.D. of the Strategies and Planning of the Territory Program in Renewable Sources of Energy, Pablo De Olavide University, Sevilla, Spain, Ph.D. in Science. Geographic.

